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# A WATER QUALITY SURVEY OF HAMPTON ROADS SHELLFISH AREAS

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By Russell S. Smith

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U. S. Public Health Service, Cincinnati, Ohio

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NATIONAL TECHNICAL INFORMATION SERVICE

# A WATER QUALITY SURVEY OF HAMPTON ROADS SHELLFISH AREAS

Details of illustrations in this document may be better studied on microfiche.

The shallow water areas in and near Hampton Roads have always been one of the most important oyster growing sections of the country. The Roads are also one of the finest natural harbors on the Atlantic Coast. With the development of shipping in the area, the port cities of Norfolk, Portsmouth and Newport News grew and developed and, in accordance with customs of the times, discharged their sewage into the nearest body of water. The menace to public health of oysters and other shellfish taken from polluted waters became evident to health officials, and the sanitary quality of these waters became a matter of increasing concern to the local, state and federal health agencies.

The waters of the Hampton Roads area present an excellent example of the effect of sewage pollution on shellfish growing waters and the improvement possible by means of sewage treatment. Here was a valuable natural resource of extensive, highly productive shellfish beds that were seriously menaced with pollution by the raw sewage from a constantly increasing urban population. As the pollution increased, the use of this great natural resource had to be subjected to ever-increasing restrictions. Finally, with collection and treatment of sewage, the quality of the waters has so improved that the restrictions imposed could be removed over much of the area.

## POLLUTIONAL HISTORY OF THE HAMPTON ROADS AREA

Many surveys of the pollution of the waters of the Hampton Roads area have been made. As a result of these surveys, ever-increasing areas of the shellfish beds have been declared unfit for the unrestricted taking of shellfish. Repeatedly, sewage treatment was recommended and warnings were given that, if treatment were not installed, further restrictions would be necessary.

(GEN. MAP HAMPTON ROADS SECTION - SLIDE 1)

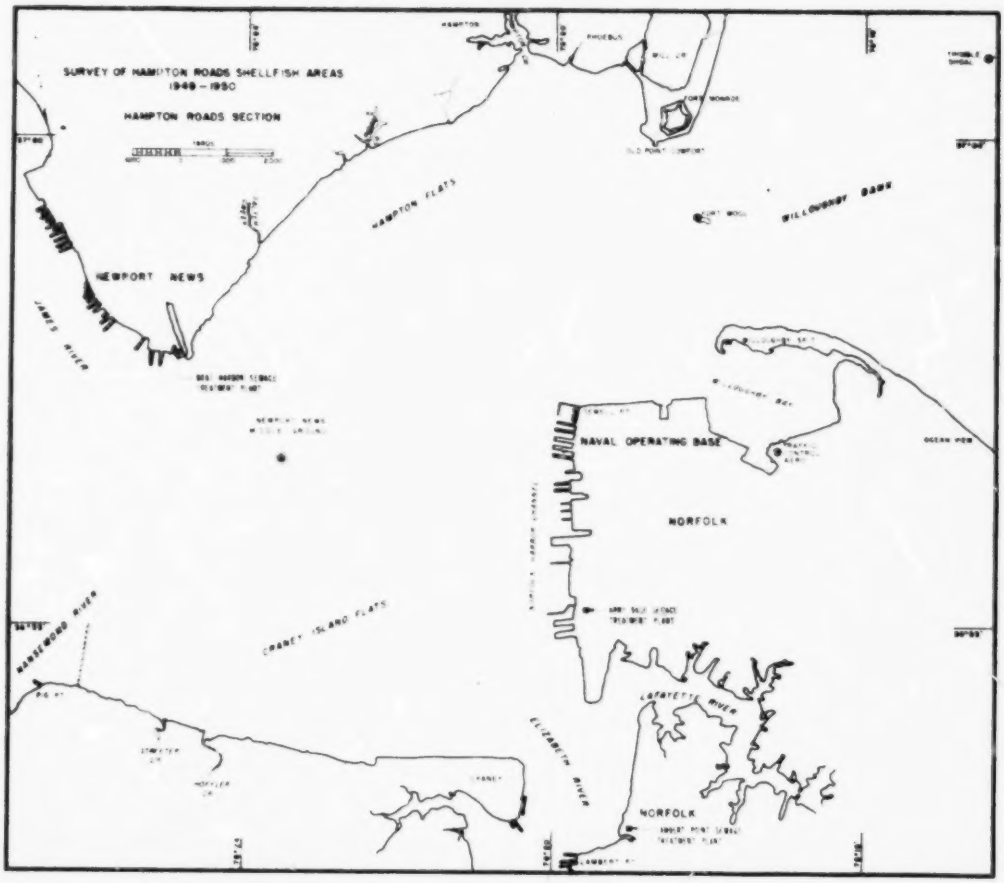
In 1914 the Public Health Service made an extensive survey of these waters. The report of this study condemned the beds in Hampton and Mill Creeks on the North Shore and in the Elizabeth River on the South Shore.

In 1926, as the result of a survey on Hampton Flats and Newport News Bar, the entire north shore of the Roads and all tributaries from Old Point Comfort to a point northwest of Hilton Village were closed to the taking of shellfish for direct marketing.

In 1934 another extensive bacteriological survey of the Hampton Roads waters was made by the Public Health Service in cooperation with the State Board of Health. No additional restrictions were placed on the shellfish growing areas as a result of this survey, but very detailed recommendations were made for the collection and treatment of sewage from the various communities tributary to the waters of the Roads.

In accordance with the recommendations of the 1934 report, the Hampton Roads Sanitation District Commission was created in 1938 for the purpose of collecting and treating sewage entering the waters of the Hampton Roads area. The City of Portsmouth withdrew from the Sanitation District to construct its own treatment facilities. The war caused postponement of plant construction, although the population of the area increased about fifty per cent.

Increased pollution of the waters during the war led to further restrictions on the use of the shellfish areas. In 1944 the east portion of Craney Island Flats from Hoffler Creek to the Norfolk Harbor Channel was closed to the taking of oysters for direct marketing. In 1946 similar action was taken for a large portion of the Willoughby Bank beds immediately outside the entrance to the Roads.


SURVEY OF HAMPTON ROADS SHELLFISH AREAS
1948 – 1950
HAMPTON ROADS SECTION
HAMPTON FLATS
NEWPORT NEWS
JAMES RIVER
NAVAL OPERATING BASE
NORFOLK
CRANEY ISLAND FLATS
NORFOLK

3-a

Thus, during the 1946-1947 oyster season, the waters of the Hampton Roads area were receiving bacterial pollution from raw sewage in sufficient amount that restrictions for oyster taking had been placed upon practically all the growing areas. The only areas from which shellfish could be taken for direct marketing were on the south shore west of Hoffler Creek and the west side of the James River.

After the war the Sanitation District and the City of Portsmouth proceeded vigorously with the construction of intercepting sewers and treatment plants, essentially as recommended in the 1934 survey report. The last plant, that of the City of Portsmouth, went into service in the spring of 1949. There are four plants, two in Norfolk, one in Portsmouth, and one in Newport News. At all plants the treatment consists of sedimentation and chlorination with digestion of the settled solids.

## WATER QUALITY SURVEY OF 1949-1950

1. General - This survey of the bacterial quality of the tidal waters in the Hampton Roads area was made during the period from October, 1949, to February, 1950, as a co-operative project of the Virginia State Department of Health and the Environmental Health Center of the Public Health Service. Valuable assistance was furnished by the Hampton Roads Sanitation District Commission, the City of Portsmouth, and the Virginia Commission of Fisheries. The survey placed particular emphasis on the waters overlying the shellfish growing areas.

At the time of this survey, certain sewered areas had not been connected to the treatment plants. On the north shore these included portions of Elizabeth City County that discharged raw sewage to Hampton Creek, a small area tributary to Indian River, the Huntington-Ferguson Park area at the east

end of the James River bridge, and scattered homes discharging to Mill Creek. In the Norfolk area there were about 35 public sewers with an estimated tributary population of 10,000 which discharged raw sewage into the Lafayette and Elizabeth Rivers. In the Portsmouth area the Naval Shipyard, the Naval Hospital, the St. Julian's Ammunition Depot, and an industrial area south of the Navy Yard had not been connected to the city sewer system. It is understood that since the completion of this survey, most of these areas have been connected to the intercepting sewers leading to the treatment plants.

(FIG. 1 & 2 - SLIDES 3 & 4 - SAMPLE POINTS)

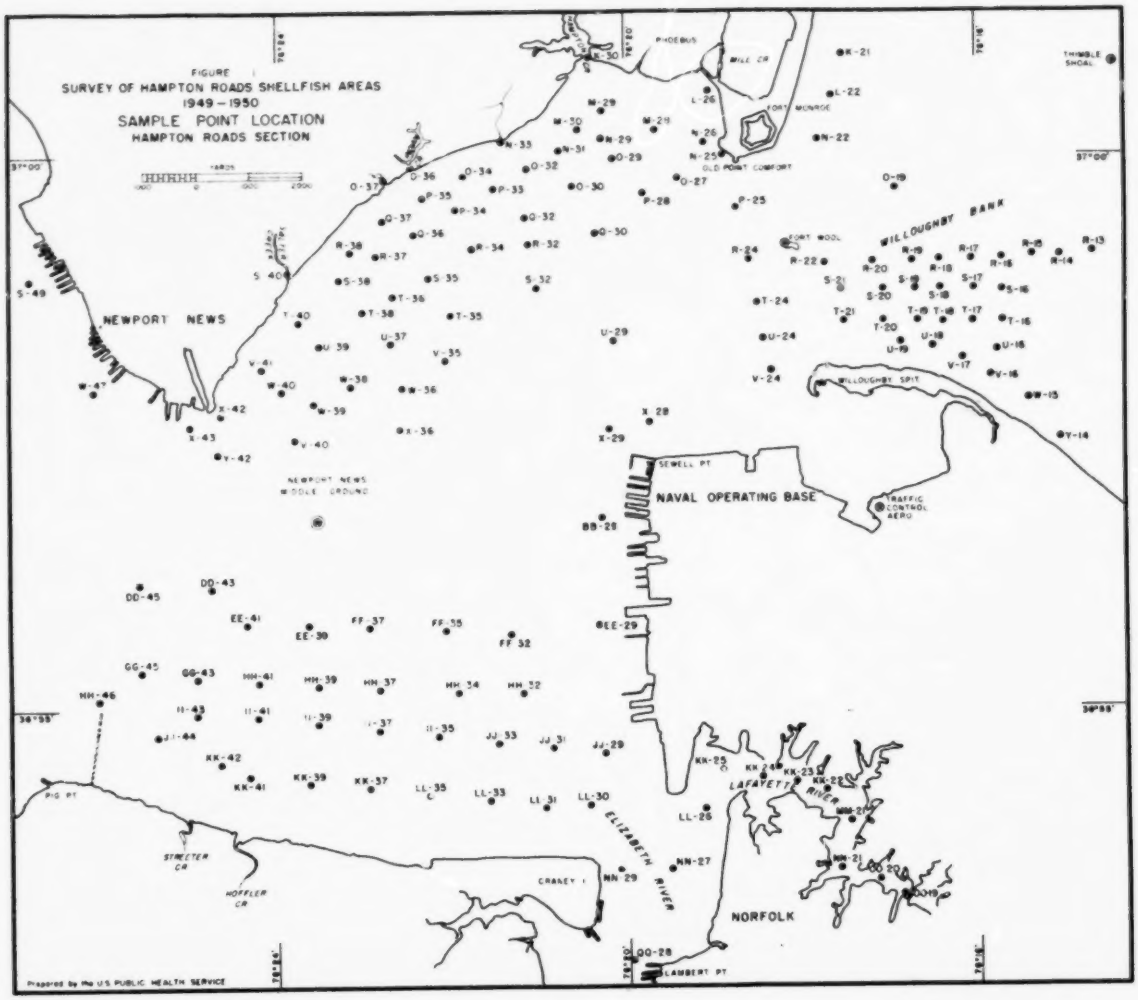
The shallow waters of Hampton Roads and the vicinity were subdivided into 9 areas for sampling purposes. In these 9 areas, 169 sample points were located to provide representative coverage of each area. Over the period of the survey, a total of 2,656 routine water samples were taken at these points. The least number of samples collected at any point was 5, the greatest number was 40, and averaged 16 samples per point.

Coliform most probable number determinations were made on each sample, planting 3 tubes in each of 3 or more decimal dilutions. All tubes showing gas in any amount within 48 hours were confirmed by inoculating into brilliant green bile lactose broth.

2. Summary of Bacteriological Results - The results obtained from these samples were summarized by tidal cycles, and the median values for flood tide, ebb tide and all tides were determined for each sample point.

(FIG. 3 - SLIDE 5)

Fig. 3 shows the coliform densities, based on median values at the various sample points, found in the waters of the Hampton Roads section. It will be noticed that the water in practically all of the shellfish-producing

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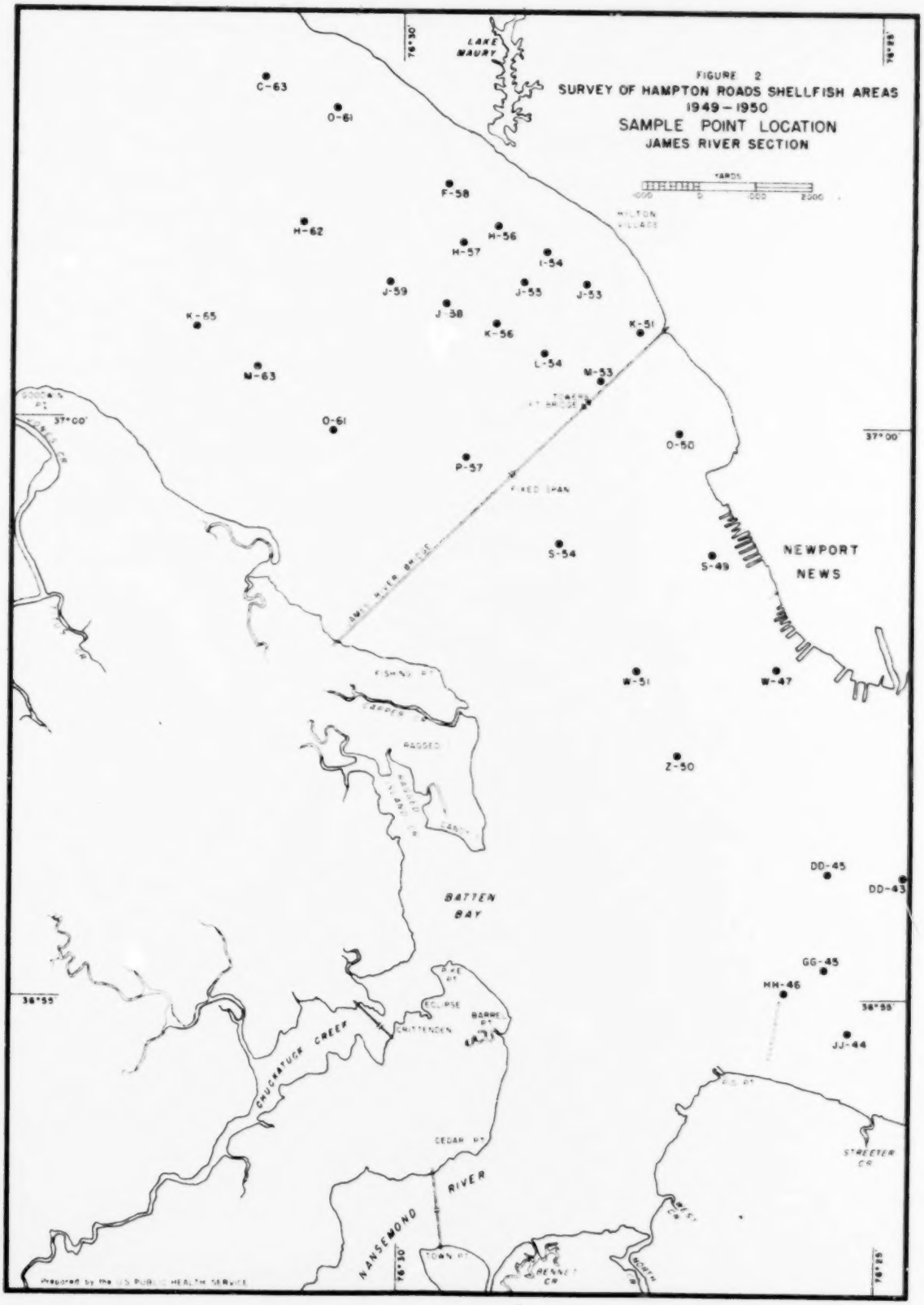
FIGURE 2
SURVEY OF HAMPTON ROADS SHELLFISH AREAS
1949 – 1950
SAMPLE POINT LOCATION
JAMES RIVER SECTION
YARDS
LAKE MAURY
C-63
O-61
F-58
H-62
H-56
H-57
I-54
J-59
J-55
J-53
K-65
J-58
K-56
K-51
L-54
M-63
M-53
O-61
O-50
P-57
S-54
S-49
NEWPORT NEWS
W-51
W-47
Z-50
DD-45
DD-43
GG-45
HH-46
JJ-44
BATTEN BAY
DRUMMONDTOWN CREEK
ECLIPSE
CHITTENDEN
BARRETT PT
CEDAR PT
NANSEMOND RIVER
STREETER CR
RENNET CR
37°00'
36°55'
76°30'
76°25'

5-4

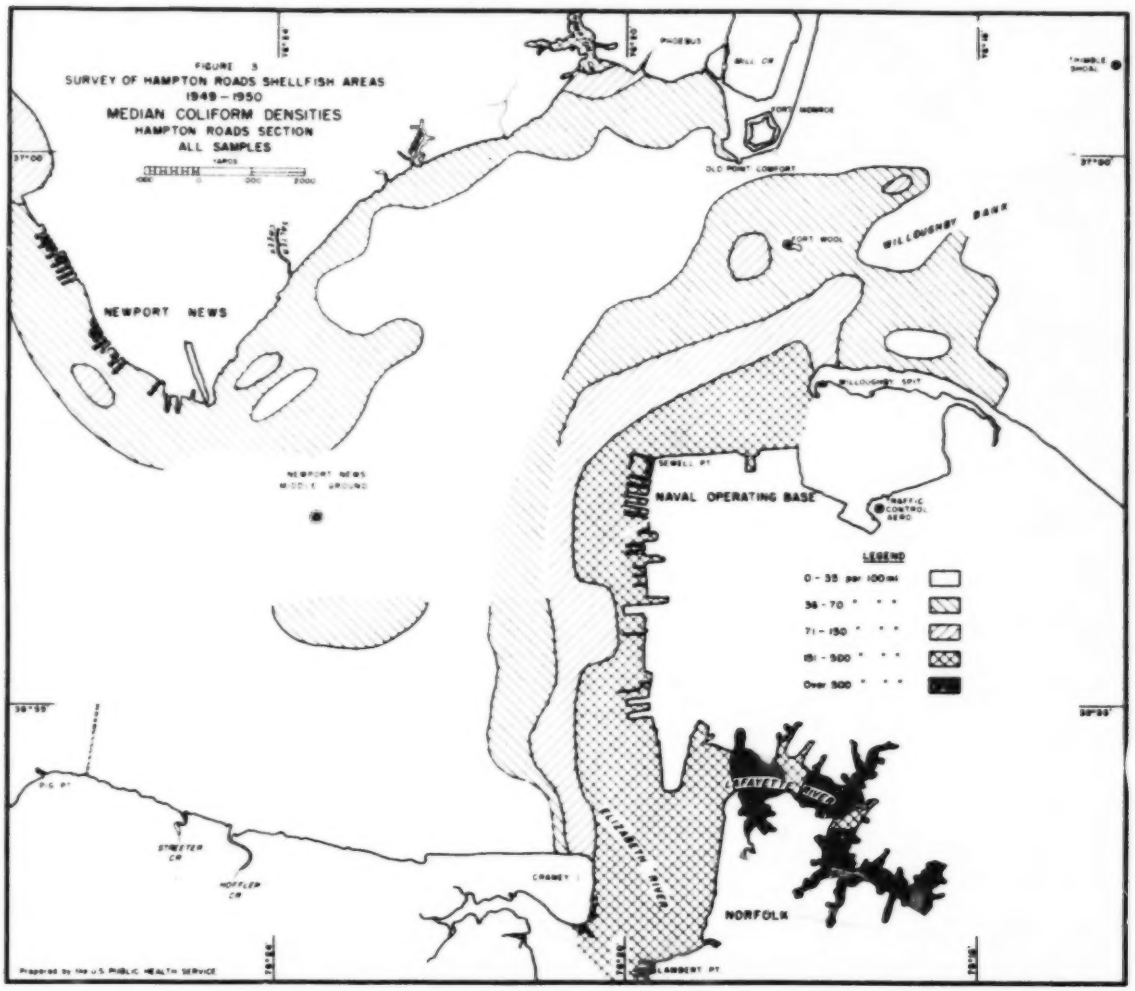
FIGURE 5
SURVEY OF HAMPTON ROADS SHELLFISH AREAS
1949 – 1950
MEDIAN COLIFORM DENSITIES
HAMPTON ROADS SECTION
ALL SAMPLES
YARDS
NEWPORT NEWS
NEWPORT NEWS MIDDLE GROUND
PHOEBUS
OLD POINT COMFORT
FORT MONROE
FORT WOOL
WILLOUGHBY BANK
WILLOUGHBY SPIT
SEWELL PT.
NAVAL OPERATING BASE
TRAFFIC CONTROL AERO
LEGEND
0 - 35 per 100 ml
36 - 70 " " "
71 - 150 " " "
151 - 500 " " "
Over 500 " " "
NORFOLK
ELIZABETH RIVER
LAMBERT PT.
CRANEY I.
HOFFLER CR.
STREETER CR.
Prepared by the U.S. PUBLIC HEALTH SERVICE

areas was found to have a quality within the limits prescribed for the taking of market shellfish (median coliform MPN of 70 per 100 ml). The only exceptions were two small areas of Hampton Flats, one close to the mouth of Hampton Creek and one just northeast of Newport News Point; and the area along the eastern edge of Craney Island Flats adjacent to the deep water channel. Flood tide results presented an even better picture, particularly on Hampton Flats and Willoughby Bank. The ebb tide samples showed that residual pollution from the Boat Harbor sewage treatment plant at Newport News Point was carried over the southwestern portion of Hampton Flats and that a median MPN in excess of 70 was found as far east as a line perpendicular to shore at Salters Creek. The ebb tide carried the pollution from the Elizabeth River and Norfolk Harbor Channel around Sewell Point and out to Chesapeake Bay. Most of this pollution was carried out through the ship channel north of Fort Wool, but a portion was pushed out over the western portion of Willoughby Bank, particularly adjacent to the north shore of Willoughby Spit.

## WATER QUALITY IMPROVED BY SEWAGE TREATMENT

A comparison of the bacteriological quality of the waters of the Hampton Roads area in 1934 and in 1949-50 provides an excellent demonstration of the effects of sewage treatment.

Fortunately, the information given in the 1934 report located each sample point and gave the arithmetric average MPN for each. These sample points were spotted on tracings of the Coast and Geodetic chart (scale 1:20,000) for the area, the average MPN was marked at each point and coliform density curves were drawn. Similar coliform density curves were drawn based on the arithmetric average MPN determined for each sample point in 1949-50. Please note that these curves are based on arithmetric averages of the MPNs

and not on the medians. The 1949-50 results showed that in this area the averages were about 3-1/4 times the medians.

(FIG. 11 - SLIDE 7)

Figure 11 shows these average coliform densities for the Hampton Roads section in 1934. Note how small a proportion of the water area had an average density less than 100 coliforms per 100 ml. Most of the Roads had a density of 101 to 500. This density extended well out over Willoughby Bank and north in Chesapeake Bay from Fort Monroe. Except at the mouth of Mill Creek, the waters along the north shore from Old Point Comfort to Newport News Point had average densities in excess of 500, while at the mouths of Hampton Creek and Indian River and along the entire Newport News waterfront the densities exceeded 1,000. On the south shore, the waters in the Norfolk Harbor Channel south from Sewells Point and in the Elizabeth and Lafayette Rivers all had average coliform densities in excess of 1,000 per 100 ml.

Let us compare these conditions with those found in the same area in 1949-50 when most of the sewage was being treated by sedimentation and chlorination before being discharged, remembering that in the interval the urban population tributary to the Roads had increased 50 per cent from 280,000 (estimated) in 1934, to 460,000 in 1950.

(FIG. 12 - SLIDE 8)

At the time of the later survey the majority of the waters had an average density of less than 100 coliforms per 100 ml. The pollution on the south side of the Roads had been so reduced that only in the Elizabeth and Lafayette Rivers and in a restricted area at the mouth of each did the densities exceed 500. Even in the Norfolk Harbor Channel past the Naval Operating Base the coliform MPN averaged less than 500 per 100 ml. The only

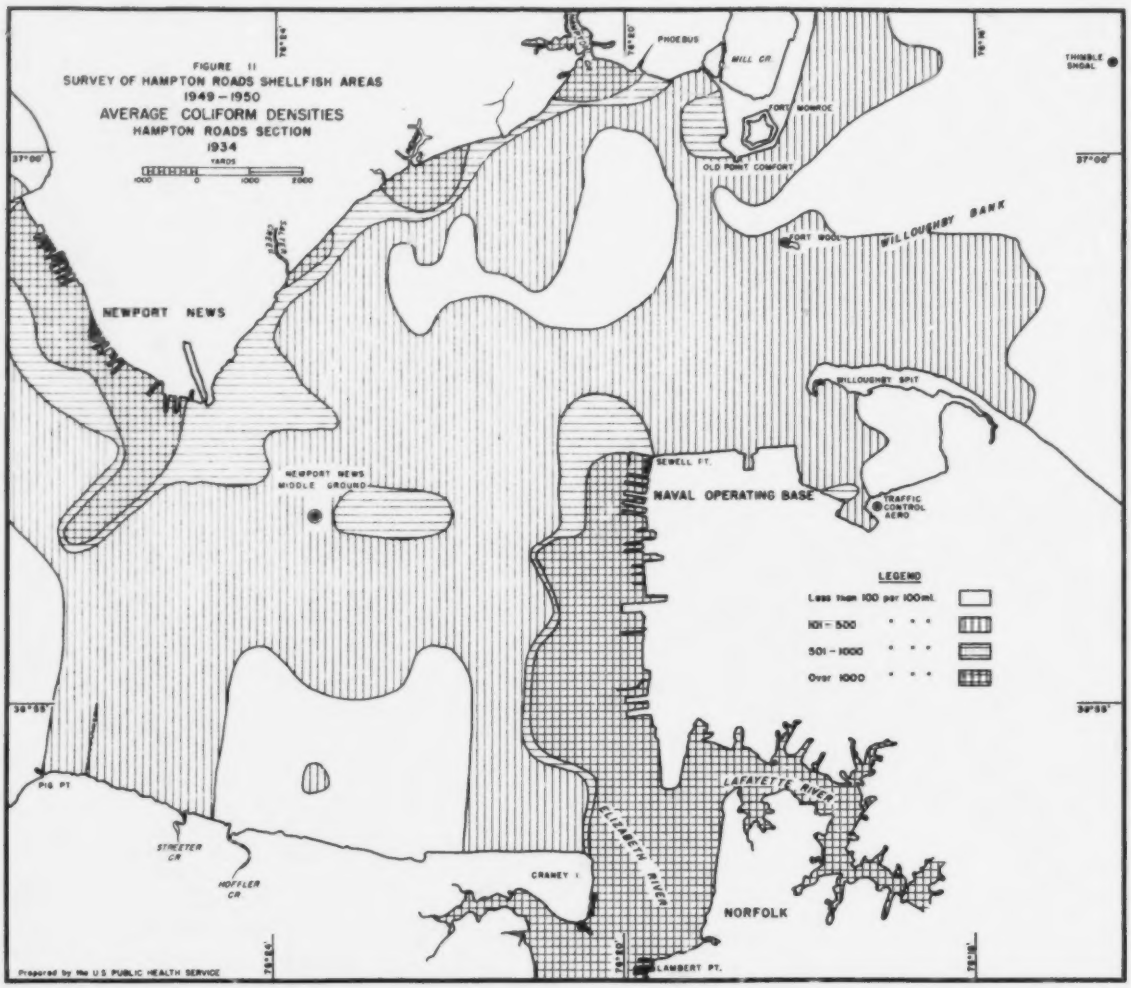
FIGURE 11
SURVEY OF HAMPTON ROADS SHELLFISH AREAS
1949 – 1950
AVERAGE COLIFORM DENSITIES
HAMPTON ROADS SECTION
1934
YARDS
1000 0 1000 2000
PHOEBUS
MILL CR.
FORT MONROE
OLD POINT COMFORT
THIMBLE SHOAL
WILLOUGHBY BANK
FORT WOOL
NEWPORT NEWS
WILLOUGHBY SPIT
NEWPORT NEWS MIDDLE GROUND
SEWELL PT.
NAVAL OPERATING BASE
TRAFFIC CONTROL AERO
LEGEND
Less than 100 per 100ml.
101 – 500
501 – 1000
Over 1000
PIG PT.
STREETER CR.
HOFFLER CR.
CRANEY I.
LAFAYETTE RIVER
ELIZABETH RIVER
NORFOLK
LAMBERT PT.
Prepared by the U.S. PUBLIC HEALTH SERVICE

7-a

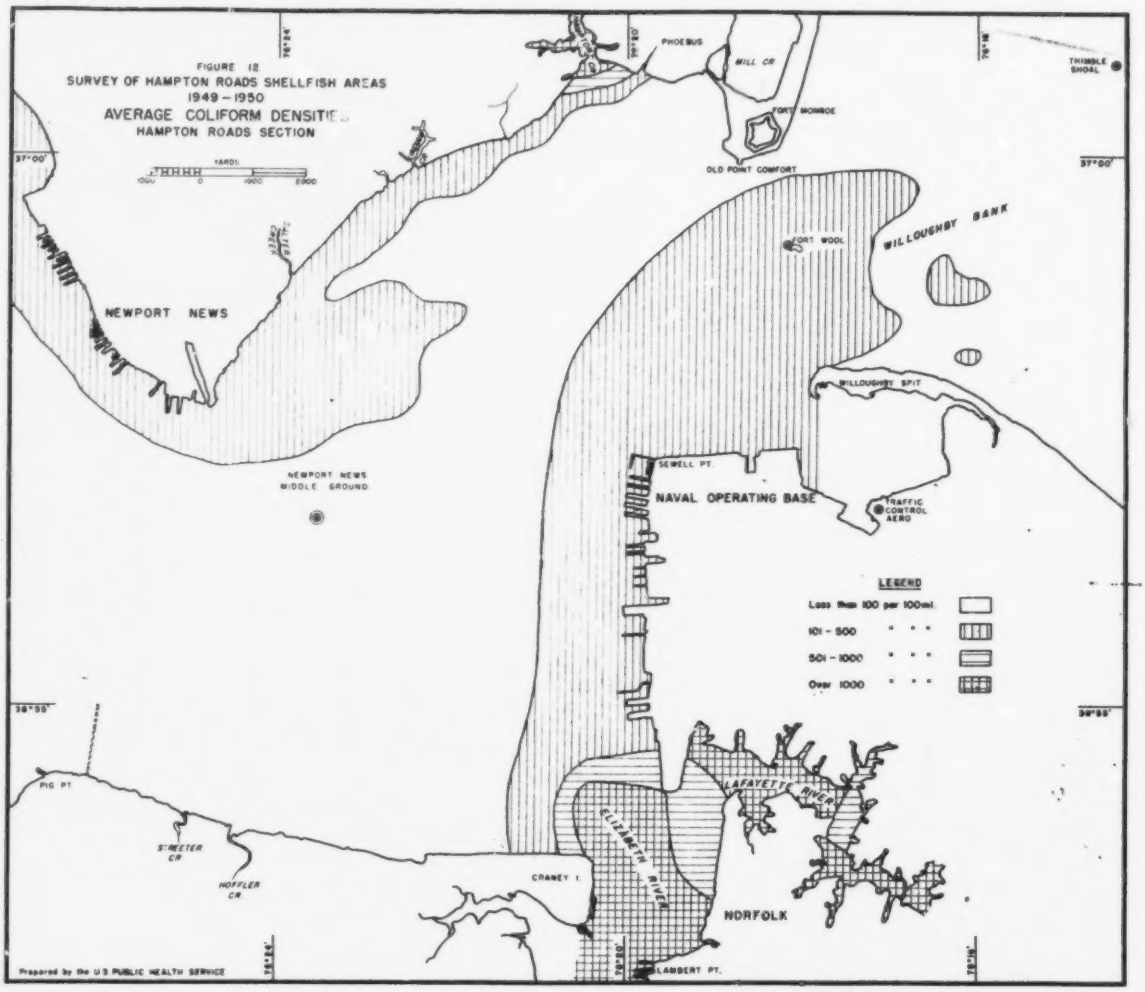
FIGURE 12
SURVEY OF HAMPTON ROADS SHELLFISH AREAS
1949 – 1950
AVERAGE COLIFORM DENSITIES
HAMPTON ROADS SECTION
YARDS
1000 0 1000 2000
PHOEBUS
MILL CR
FORT MONROE
OLD POINT COMFORT
THIMBLE SHOAL
37°00'
NEWPORT NEWS
NEWPORT NEWS MIDDLE GROUND
FORT WOOL
WILLOUGHBY BANK
WILLOUGHBY SPIT
SEWELL PT.
NAVAL OPERATING BASE
TRAFFIC CONTROL AERO
LEGEND
Less than 100 per 100ml.
101 - 500
501 - 1000
Over 1000
36°55'
PIG PT.
STREETER CR.
HOFFLER CR.
CRANEY I.
ELIZABETH RIVER
LAFAYETTE RIVER
NORFOLK
LAMBERT PT.
Prepared by the U.S. PUBLIC HEALTH SERVICE

7-b

sample point in the entire northern section that had an average density in excess of 1,000 was in the mouth of Hampton Creek. The average coliform MPN in the Fort Monroe area of Chesapeake Bay had declined from approximately 150 per 100 ml. in 1934 to less than 50 in 1949-50.

EFFECT OF ADEQUATE CHLORINATION ON RECEIVING WATERS

When the 1949-50 survey started in October, there was insufficient chlorinator capacity at the Boat Harbor sewage treatment plant in Newport News to afford adequate chlorination to the strong daytime flows. An additional chlorinator was on order, but it was not installed and in service until December 1.

At two of the plants (Army Base and Portsmouth) there were chlorine contact tanks, but apparently there was insufficient turbulance to mix the chlorine properly with the settling tank effluent before it entered these contact tanks. At the Boat Harbor and Lambert Point plants there were no contact tanks and reliance was placed on the theoretical detention period in the submerged outfalls to provide the necessary contact time.

The operating personnel of the Hampton Roads Sanitation District believed that adequate mixing was not being obtained in the outfall sewers at Boat Harbor and Lambert Point plants and that better control of the chlorine residual could be obtained by applying the chlorine ahead of the settling tanks. This change in procedure was made in the plants of the Sanitation District by December 1 and in the Portsmouth plant on January 25.

In November, arrangements were made with the Hampton Roads Sanitation District Commission to have bacteriological samples of the chlorinated effluents taken at each of their plants at 2:00 A.M., 4:00 A.M., and 6:00

A.M., and at 10:00 A.M., 12:00 Noon and 2:00 P.M. These samples were composited in the laboratory into two samples representing the weak and strong flows of the day and coliform determinations were made on the composited samples. Similar samples were taken at the Portsmouth plant. The results from these samples showed a general improvement in chlorination efficiency after December 1. This was particularly noticeable at the Boat Harbor plant which had an effluent median coliform MPN of 1,600,000 per 100 ml. prior to December 1 and less than 30 after that date.

Because of the difference in chlorination efficiency, the results of the routine water samples were divided chronologically into two periods, prior and subsequent to December 1. The medians for each sample point were determined for each period and coliform density curves were plotted.

(FIG.13 - SLIDE 9)

Fig. 13 shows the water quality found in the Hampton Roads section during October and November when the Boat Harbor plant had a median coliform MPN of 1,600,000 per 100 ml. It will be noted that the southwest end of Hampton Flats showed relatively high pollution and that the pollution from the Elizabeth and Lafayette Rivers extended north along the Norfolk Harbor Channel and around Willoughby Spit to Willoughby Bank.

(FIG. 14 - SLIDE 10)

Fig. 14 shows the conditions in the same area after December 1. Hampton Flats is shown to have been greatly improved. In fact, only one sample point had a median value over 70 and that did not exceed 150. It is believed that the improvement in the Craney Island Flats area is correlated with the improved effluent from the Boat Harbor plant and the improved conditions on Hampton Flats. On ebb tide a portion of the Boat Harbor plant effluent is carried

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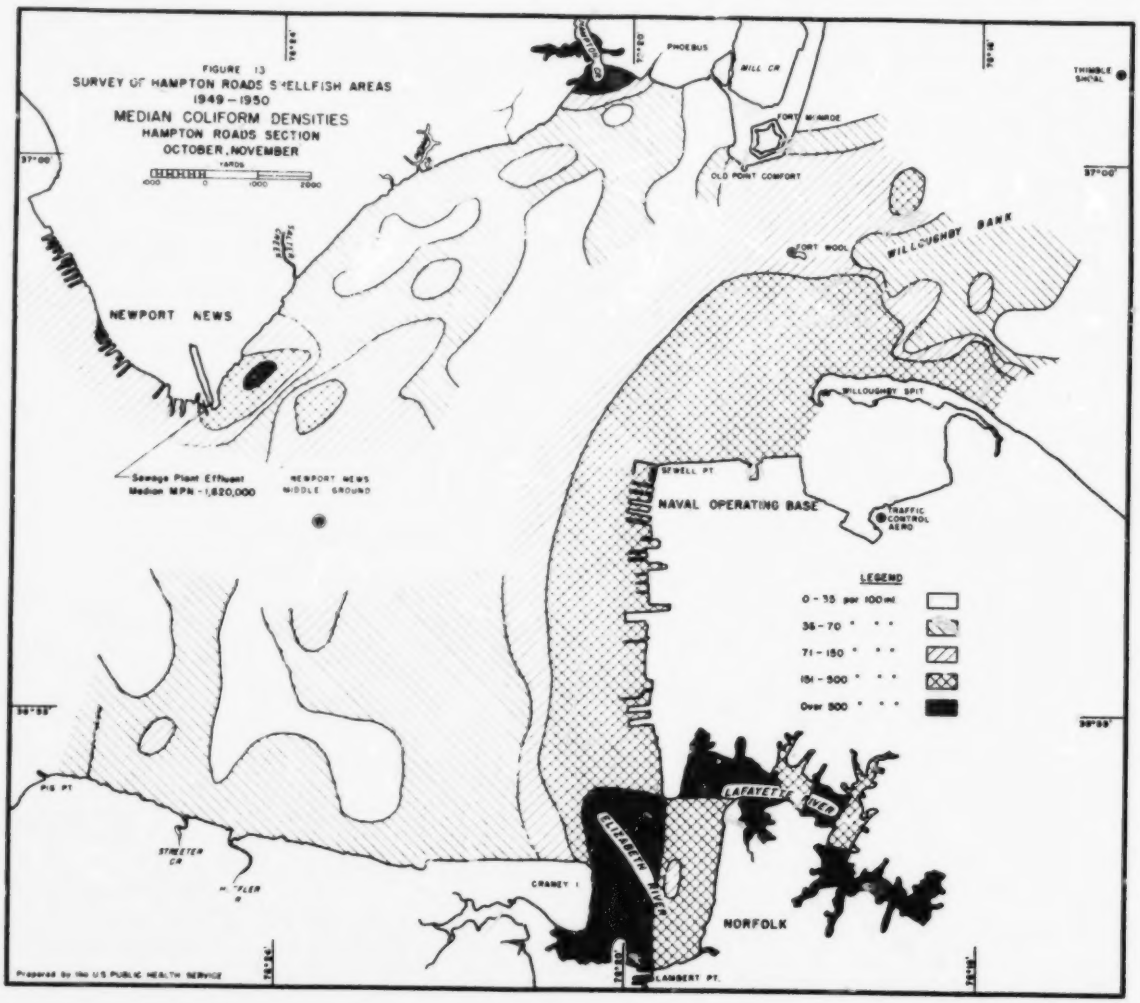


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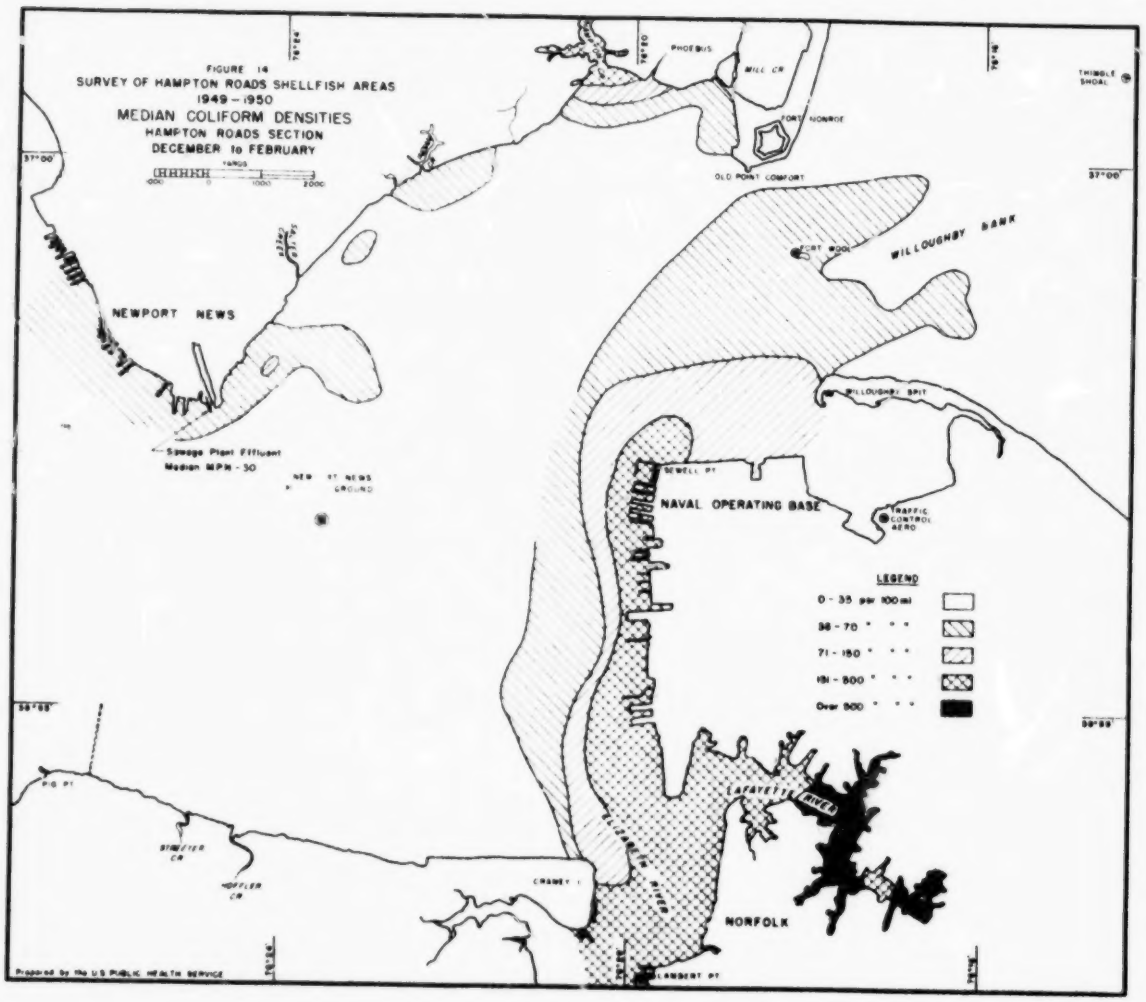


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through a depression northwest of Hampton Bar and over the flats, but the larger portion passes down the main channel toward the entrance to the Roads. On flood tide this diluted effluent in the main channel is pushed back upstream and floods over both Hampton and Craney Island Flats. It will also be noted that in December and January the band of heavily polluted water in the Norfolk Harbor Channel is much narrower than during the previous period and does not extend much beyond Sewell Point at the north end of the Naval Operating Base.

## EFFECT OF SURVEY ON OYSTER GROWING INDUSTRY

Consideration of the water quality found in the various sections of the Hampton Roads area during this survey led to the recommendation that consideration be given to reopening for direct taking of market oysters certain sections of the oyster growing beds. Such reopening would be subject to the maintenance of certain conditions in the naval anchorages and continuation of satisfactory sewage treatment. The areas recommended for consideration were as follows:

1. Hampton Flats - The central portion of the flats from about 1,000 yards offshore to the deep water channel. This area covers 1,470 acres.
2. Willoughby Bank - A triangular section west of the existing restriction line, with its base on the ship channel and its apex on the existing restriction line 1,000 yards off Willoughby Point, with an area of 1,300 acres.
3. Craney Island Flats - The portion of the flats from the existing restriction line (800 yards east of Hoffler Creek) to a line about 1,000 yards west of the Norfolk Harbor Channel. This portion of the flats has an area of 4,100 acres.

Thus this survey indicated that, as a result of the collection and treatment of municipal sewage in the Hampton Roads area, a total of 6,800 acres or 10 square miles of previously restricted shellfish growing areas might be released for the taking of oysters for direct marketing.